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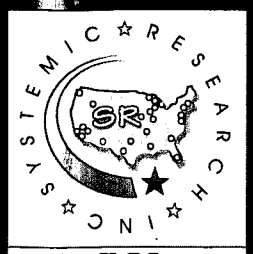
ABSTRACT

This review of selected literature examines the National Science Foundation's standards-based systemic reform theory in the context of research reported by science, mathematics, and urban education policy experts. This review is specifically concerned with viewing evidence of relationships among identified change variables that are associated with fostering high achievement in mathematics and science of urban and underrepresented minority students. Four categories of variables are identified as being useful in studying student achievement: (1) demographic information; (2) test data; (3) teacher development; and (4) mathematics and science curriculum. The review reveals little researcher agreement regarding variable relationships that might predict a chain of influence from policy to classroom practice and finally to student performance. An appendix contains an abstract of the proposed Urban Systemic Initiative evaluative study. (Contains 124 references.) (Author/SLD)



USI
EVALUATIVE
STUDY

Standards

Study Monograph No. 1

How Reform Works: An Evaluative Study of NSF's Urban Systemic Initiatives

What Matters in Urban School Reform

Melva Ware, University of Missouri- St. Louis
Lloyd Richardson, University of Missouri- St. Louis
Jason J. Kim, Systemic Research, Inc.

Funded by the National Science Foundation
Directorate for Education and Human Resources
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Dr. Kim has been involved in educational reform programs for K-12 and college level in various capacities since 1993. Most recently he received a three-year grant from the National Science Foundation (NSF) to conduct an evaluative study to explore the impact of NSF's Urban System Initiatives, entitled "How Reform Works." He designed, developed, and implemented the numerous evaluation and assessment instruments for K-12 and college level programs sponsored by federal or state governments. Dr. Kim has published numerous papers and provided workshops and consultations in the area of educational evaluation and assessment, and information management systems and technologies. Dr. Kim founded Systemic Research, Inc. in 1995 to provide expertise in educational evaluation/information management systems. Prior to founding Systemic Research, Inc., he was a faculty member for ten years in the College of Engineering of Northeastern University, Boston.

CONTENTS

PREFACE

The primary purpose of this monograph is to facilitate an initial literature review relevant to our study granted by the National Science Foundation- "How Reform Works: An Evaluative Study of NSF's Urban Systemic Initiatives." The three-year evaluative study explores the impact of USI programs on student achievement and the learning infrastructure in urban school districts, and will develop an inferential causal model linking the Systemic Initiatives drivers and other key elements. The study design includes collection and analysis of all 21 USI sites' quantitative and qualitative data, site visits in four districts in each cohort, and the Survey of Enacted Curriculum. This monograph provides a basis for the rubric design of the evaluative study- See Appendix A: USI Evaluative Study Abstract.

ABSTRACT

What Matters in Urban School Reform

This review of selected literature examines the National Science Foundation's standards-based systemic reform theory in the context of research reported by science, mathematics, and urban education policy experts. This review is specifically concerned with viewing evidence of relationships among identified change variables that are associated with fostering high achievement in mathematics and science of urban and underrepresented minority students. The authors indicate that four categories of variables are useful in studying student achievement: demographic information, test data, teacher development, and mathematics and science curriculum. The review revealed little researcher agreement regarding variable relationships that might predict a chain of influence from policy to classroom practice and finally to student performance.

INTRODUCTION AND STUDY BACKGROUND

Response to Access Challenges:
A History of the National Science Foundation's
Systemic Reform Efforts in Urban Schools

In the 1980's the National Science Foundation (NSF) joined other government and policy agencies in the nation's most recent efforts to improve K-12 education by improving learning outcomes. Based on evidence of lagging performance by American school children on international measures, the Congress joined the nation's governors and various discipline-anchored education associations to endorse creation of content standards and their implementation through broad-based systemic reform.

The NSF commitment to support improvement in K-12 learning outcomes of American students was evident in the creation of the Directorate for Education and Human Resources (EHR). In 1990, EHR began formulating strategies to address the lack of synchronization between the preparation of K-16 students and projected workforce demands. Given anticipated demographic shifts, of particular concern to NSF leaders was the underrepresentation of blacks, Hispanics and other minorities in the science and engineering workforce (Massey, 1992). By 1992, NSF faced a dismal reality in reviewing its 20+ year record of efforts to increase access for under-represented populations to careers in the sciences.

With EHR leadership, NSF revised the mission of its Career Access program. The Foundation changed its emphasis from university level programs to an emphasis on pre-collegiate approaches. These approaches are designed to "strengthen student science, mathematics, and technology literacy through curriculum reform, teacher enhancement, student enrichment, and other activities" (NSF, 1992, p. 7).

Students of all races filter out of science and engineering so that only a fraction of interested high schoolers--1.4%--earn Ph.D.s. But the minority pipeline, smaller to begin with constricts even more sharply than that of the total population; only 0.4% of minority students emerge with Ph.D.s in science or engineering (Culotta & Gibbons, 1992, p. 1212).

The revised vision for NSF's K-12 programs reflected guidance from professional groups such as the National Council of Teachers of Mathematics (NCTM), the National Research Council (NRC), the American Association for the Advancement

of Science (AAAS), and the National Science Teachers Association (NSTA). These groups developed content and evaluation standards, to guide curriculum reform and teacher retraining; thereby, framing "what" students should know and be able to do, in order to achieve target competence.

In 1994, concerns about implementing standards converged with the formulation of national education goals by the Governors Association. The governors adopted Goals 2000 and supported Congressional action to adopt the Educate America act which set the terms for "how" schools would respond to new demands for better quality teaching and improved learning outcomes. Congressional demand for rigorous, clear content and pedagogical standards signaled significant change in the terms of relationships between federal funding agencies and state and local school districts. NSF leveraged movement toward systemic reform through grants to states and subsequently to urban school districts.

State Systemic Efforts Set the Stage for Urban Systemic Efforts

Responsibility for education in U.S. schools resides at the state level. State-level policies have increasing influence in three areas: development of content standards, state-wide assessment of student learning, and teacher preparation and licensure (Blank and Langesen, 1999). States have assumed leadership roles in aligning state policy to achieve standards-based reform. In several states, state-level policy guides selection of textbooks and other classroom curriculum materials (Blank and Langesen, 1999). The Council of Chief State School Officers (CCSSO) serves as a clearinghouse to facilitate inter-state communication about progress in development and implementation of reform policies.

With state guidance, local districts are challenged to develop new policies designed to up-grade K-12 education, with particular emphasis on increasing instructional time spent on improving the quality of mathematics and science learning in American schools. In order to comply with higher state standards, school districts work to modify policies, which govern graduation requirements and teacher qualifications. Emerging student and teacher state assessment programs are aligned with new curriculum standards.

Premised on assumptions that clear, rigorous standards are necessary to improve student performance, particularly in mathematics-based subjects, standards-based reform defines common expectations for high levels of academic competence. Urban, suburban and rural schools are subject to the same standards. School districts are challenged to respond to "state established policies [that] define "district and school accountability for educational progress of students" (Blank and Langesen, 1999, p. 2).

Systemic Reform as an Equity Tool

Urban systemic reform embraced strategies conceptualized to increase educational opportunity for urban poor and minority children. National interest was prompted by concerns about a retreat in equity progress, particularly in light of changing demographics, as a factor in national economic competitiveness.

Following a seventeen-year record (1971-88) of achievement gains for African American students, 1990 National Assessment of Educational Progress (NAEP) scores indicated a reversal of progress, with an increasing gap between the achievement scores of whites and African American children. According to researchers Smith and O'Day (1991), during the period of progress, emphasis on basic skills instruction and testing constituted a national standard for educating urban poor and minority students. Minimum competency standards and improved social conditions narrowed achievement gaps, but failed to provide access to adequate curriculum for competitive achievement. The problem of the continuing gap is exacerbated by social realities that followed the period of civil rights progress. During the final decades of the 20th century, hyper segregation and high poverty rates characterized conditions in most urban communities (Orfield and Ashkinaze, 1991; Denton and Massey, 1993). Urban social realities combined with the basic skills curriculum offered in urban schools limit access to complex knowledge and skills assessed by the emerging standards-based state assessments (Smith and O'Day, 1991).

NSF and other federal agencies directed funding to energize comprehensive change at all levels of the education enterprise, including the school district level, the school building level, and in the relationships between schools, associated universities, industry, and other societal partners. To qualify for funding, local education agencies adopted systemic reform terms consistent with those outlined by policy researchers (Smith and O'Day, 1991; Fuhrman, Elmore and Massell, 1993). These terms are expressed as reform "drivers." According to the NSF, there are "six critical developments that drive systemic change" (Westat*McKenzie, January 1998, p.13).

School districts prepared to redesign their operations to implement systemic change based on NSF's Driver model. NSF engaged districts through contractual relationships that established terms for sustained activities, based on "systemic and comprehensive approaches." The Urban Systemic Initiative (USI) focused resources on school districts in communities with high numbers of children living in poverty, and the lowest levels of academic achievement. The USI "was established [to support] sustained science and mathematics education reform in the nation's largest--and poorest--urban centers" (Westat*McKenzie, October 1998, p. 7).

Six Drivers for Educational System Reform

1. *Implementation of comprehensive, standards-based curricula as represented in instructional practice, including student assessment, in every classroom, laboratory, and other learning experience provided through the system and its partners.*

2. *Development of a coherent, consistent set of policies that supports: provision of high quality mathematics and science education for each student; excellent preparation, continuing education, and support for each mathematics and science teacher (including all elementary teachers); and administrative support for all persons who work to dramatically improve achievement among all students served by the system.*

3. *Convergence of the usage of all resources that are designed for or that reasonably could be used to support science and mathematics education--fiscal, intellectual, material, curricular, and extra-curricular--into a focused and unitary program to constantly upgrade, renew, and improve the educational program in mathematics and science for all students.*

4. *Broad-based support from parents, policymakers, institutions of higher education, business and industry, foundations, and other segments of the community for the goals and collective value of the program, based on rich presentations of the ideas behind the program, the evidence gathered about its successes and its failures, and critical discussions of its efforts.*

5. *Accumulation of a broad and deep array of evidence that the program is enhancing student achievement, through a set of indices that might include achievement test scores, higher level courses passed, College admission rates, college majors, Advanced Placement Tests taken, portfolio assessment, and ratings from summer employers, and that demonstrate that students are generally achieving at a significantly higher level in science and mathematics.*

6. *Improvement in the achievement of all students, including those historically underserved.*

Following a 1996 retreat convened by National Science Foundation program officers, the Foundation issued detailed guidelines for building equity into NSF systemic reform initiatives. The guidelines clearly outline expectations that "equity is an essential and inherent component of high-quality mathematics and science at all levels" (Westat*McKenzie, 1997, p.6). The guidelines call for accommodating wide variation in approach to ensure that subgroups of people do not experience systemic discrimination in process, opportunity nor outcomes. This guidance interprets NCTM and NRC standards as implicating "a need to go beyond equal access and treatment to understand various learning styles, and motivations among students." It also calls for making "adaptations to meet the needs of special students, and to provide opportunities for those students interested in and capable of moving beyond the basic program" (Westat*McKenzie, 1997, p.18). The Foundation established expectations that outcomes of systemic reform would include proportional representation among high achievers of students from the range of social, ethnic, racial, and economic groups comprising the American population.

Evaluating USI implementation, then, requires viewing local district outcomes within the context of each district's adaptations of its state's standards-based curriculum and assessment systems. Determining the alignment between the urban district's curricula and that of the state must incorporate a view of the district's adaptive features that support success for diverse learners.

Scope of the Current Literature Review and Concerns of the Related Study

NSF's approach is considered logical, clear and comprehensive by many researchers. Others studying reform implementation find wide, perhaps unwieldy, variation in state and local reform initiatives (Knapp, 1997; St. John & Pratt, 1997; Long, 1996). The literature is reviewed to relate NSF's implicit standards-based reform theory to ideas and issues advanced by science, mathematics, and urban education scholars.

While the NSF-identified reform drivers are key research variables, the literature review indicates that variation among the perspectives of key stake-holders, such as teaching and learning experts, about desired teacher and student behavior within a standards-informed learning environment implicates equity concerns as an additional and influential variable. The NSF *Equity Implementation* guidance was issued in January 1998, and 22 of the 28 USI's were funded prior to 1996.

As this study investigates the interaction of "standards" (what all students should know and be able to do) and process variables (curriculum content and instructional process), as evidenced by benchmarks (grade level achievement "snapshots"), the emerging variable interaction model should be sensitive to critical variation in policy interpretation and implementation. Data such as the content and process claimed as professional development, as well as the beliefs and backgrounds of system administrators and teacher trainers yield important insight about relationships among change variables.

Other NSF commissioned studies also inform this research. Conclusions from the initial analysis of the relationship between state standards and assessments indicate that researchers believe their emerging study strategies are useful in viewing synchronization between content planned and content assessed. Viewed with results of the Survey of Enacted Curriculum, alignment studies that incorporate evidence of urban standards-based curricula adaptations charted to support success of urban students will likely provide a useful indicator of the implementation status of content standards in urban districts.

This literature review necessarily reflects the range of responses reported by researchers to the underlying mission and approach to systemic reform. This study of *How Reform Works* is concerned with the relationships among change variables, particularly as those relationships are associated with positive changes in student achievement and system outcomes. In this regard, the current review attempts to examine the NSF's theory of reform, against the background of research reports that reflect theoretical and application-driven insights about fostering high achievement of urban and underrepresented students, particularly in mathematics and science.

NSF'S REFORM THEORY AND RESEARCH VARIABLES

What Variables are Used in Research on Mathematics and Science Achievement of Urban and Underrepresented Students?

Based on a survey of current literature, variables found to influence performance in science and mathematics fall into four categories: demographic information, student performance information, mathematics and science curriculum, and teacher professional development.

By the year 2000, Anderson (1990) indicates that approximately one-third of the nation will be minority. It is expected that almost one-third of the nation's jobs will require a college education and that nonprofessional jobs will require increasing skills in mathematics and reasoning. Anderson views mathematics as an economic, social, and psychological enabling force and a filter that allows students the option of an unlimited number of careers both professional and nonprofessional. Two case studies discussed in the journal article underscore the importance of educators' high expectations and encouragement of minority students in mathematics.

Rech and Stevens (1996) in an article entitled "Variables related to mathematics achievement among black students" appearing in *The Journal of Educational Research* reported that extensive research has been compiled to compare the mathematical achievement of black and white students. The findings of these studies have consistently shown that black students have been significantly outperformed by non-black students at all grade levels. Blacks, as a group, have not been expected to perform well in mathematics leading to learned helplessness and lower teacher expectations. The authors, Rech and Stevens, designed a study to determine the effect of four specific characteristics on the mathematical achievement of fourth- and eighth-grade black students. The goal of their research was to obtain information to use in developing instructional interventions to improve achievement for this group of students. Strict scientific methods were used in gathering and analyzing the data.

The results showed that there were significant differences between the fourth- and eighth-grade students. Attitude and economic status were found to be predictors of mathematical achievement in fourth graders. The authors suggest that educators need to take steps to improve negative attitudes. Students need to be made aware of the relevance of science and math to their everyday lives and its value in society. It is also important that students are given many opportunities to be successful in

science/mathematics to counteract these negative attitudes. Given that economically disadvantaged black students are more likely to fail, special social programs are needed to address this situation.

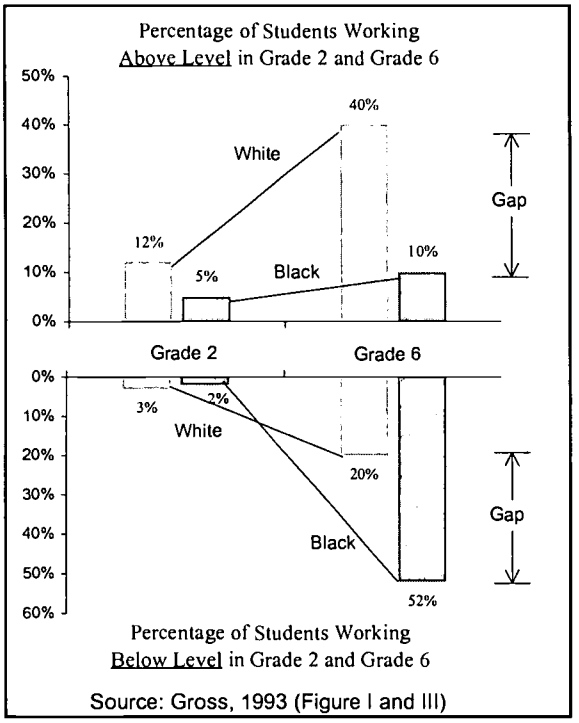
It was interesting to note that even though the eighth graders in the sample possessed more negative attitudes toward math than the fourth graders, attitude was not a significant predictor of achievement. The research study found that learning styles and gender were predictive factors for black eighth-grade achievement. Educators need to learn to teach to a variety of learning styles with an emphasis on the active engagement of students through a variety of concrete, hands-on, learning experiences. Mathematical learning activities should be relevant and provide a global perspective. The study also revealed that eighth-grade black males achieve at a lower level than the females. Two recommendations to rectify this situation are to bring black male role models into the classroom and to design instructional strategies that specifically target black males.

The students in this sample had a mean percentile score of 47.2 in the fourth grade which dropped to 37.0 in the eighth grade compared to scores of 60.6 and 57.7 for white students, respectively. Rech and Stevens indicate this is unacceptable. In an advanced nation such as the United States, one cultural group's achievement should not be allowed to lag so far behind. They argue that educators have the ability to positively impact at least three of the four predictors of achievement. Teachers can positively impact the attitude of fourth graders by making mathematics relevant to the students' everyday lives and fun. They can design activities that promote positive learning experiences and allow all students to be successful. Through a partnership with school and the community, positive black male and female role models should be brought into the classroom and mentoring programs established. Teachers need to be educated in different learning styles and be given the support to provide active, hands-on activities that will engage all students. The only factor that educators cannot correct on their own is the effect of poverty on children's learning. A concerted effort involving the community and social service agencies in partnership with the schools is necessary to positively impact economic status.

Gross (1993) reported a study in the *Journal of Negro Education* with data derived from work done in 1988. He noted that the school district used for data collection had placed a priority on the education of minority students and the equitable representation of these students in advanced level classes. Also, minority students in this district had outscored minority students nationwide and in many cases had scored better than all students in their age/grade level in the test publisher's norming group. Even so, there were large differences in the scores of minority and majority students in this school district.

Following are the major findings from Gross's study:

- ❖ This school district assesses behavioral objectives at each grade level. In first grade, the students start out virtually the same with almost all students on grade level. Significant differences appear by the end of second grade and the gaps widen every year. At the end of sixth grade, 40% of whites were above grade level compared to just over 10% of blacks, and the percentages of students working below grade level were about 20% and 52% for whites and blacks, respectively.



Source: Gross, 1993 (Figure I and III)

- ❖ African American students scored on average 15 NCE points below their white counterparts on the California Achievement Test (CAT) in fourth, sixth, and eighth grades and 20 and 4 NCE points below the Asians and Hispanics in their school district, respectively.
- ❖ The author performed factor and regression analyses to investigate the relationship of class performance, attitudes, and behaviors of students to performance on the CAT. The variable that was found to account for approximately one-half of the variance in scores was students' performance in the mathematics curriculum.
- ❖ Interviews of school staff revealed that societal factors were blamed for the discrepancy in the achievement between minority and majority students. Teachers were asked to rate students on several aspects of classroom behavior. Findings were that black students were judged less studious by their teachers as well as less prepared and careful in their schoolwork. In the fourth- and sixth-grade samples of teachers, majority students were rated significantly higher in overall ability when compared to their minority counterparts.

Gross notes in her study that strong relationships were observed between students' performance in the school's mathematics curriculum and their mathematics achievement. She concludes that an early emphasis on all aspects of the mathematics curriculum will lead to higher achievement for minority students. She also feels that school administrators and teachers perceive that minority students are less interested in and less capable of success in mathematics. She recommends that a key component of improving mathematics achievement for minority students lies in training teachers to provide mathematics instruction using a constructivist approach although no evidence is presented to support this assertion. Gross emphasizes that teacher in-service must educate teachers using the same methods that they will be expected to employ in their classrooms. Emphasis should be placed on teachers' questioning and listening abilities. Gross speculates that attitudes and

beliefs of teachers about who is capable of doing math will change as interaction and collaboration between students and teachers increase.

The author seems to be accounting for the underachievement of minority students as partly due to teachers' stereotyping and preconceptions. The author states that constructivism takes the pressure off of the teacher to "cover the curriculum". One would hope that teaching using a constructivist approach would allow all students to master concepts and skills so that they can be built upon rather than retaught every year.

Davidson and Kramer (1997) make the case that major change is necessary in three areas to empower all students to achieve in mathematics. The easiest of these areas to change is curriculum. The authors give several examples demonstrating how the mathematics of a culture can be used to explore a mathematical concept that is developmentally appropriate, and conversely, how the study of a culture can present opportunities to use mathematics within that context.

Secondly, the authors call for teachers to take a hard look at how we teach and our attitudes and perceptions of our students. They emphasize the importance of students' construction of knowledge and the use of cooperative learning. Teachers must actively encourage positive inter-group interactions, which will help to reduce prejudice and level the multicultural playing field.

Davidson and Kramer make an interesting point that students' preparation for school depends on how well their culture matches the culture of the school they attend. Children who come from different cultures need to be taught the rules. Furthermore, to have more opportunities to succeed in the United Stages, students must learn the rules of the middle- to upper-class white culture that is in power. This theory has definite implications for urban inner city schools and our society as a whole.

There is a discussion of whether the emphasis should be placed on traditional technical skills or the currently popular conceptual or developmental approaches. Davidson and Kramer present evidence that no one approach will serve all children. Necessary components of successful teaching are validation of students, demand for excellence, collaborative learning, and the learning of skills within the contexts of problem solving and critical thinking.

Thirdly, the culture of our classrooms needs to change in order to truly value all cultures. This must start with the teacher and emanate from him/her. By actively including in our lessons a variety of cultures, we show the students that differences are valued. Rather than making our classrooms into a 'melting pot' where all students are treated the same, we should investigate and celebrate our differences.

The premise of the authors appears to be valid; but putting these major changes into effect concurrently in science/math classrooms seems to be a daunting task. Take, for example, the call for cooperative learning. This is a practice that most teachers understand, but as Davidson and Kramer report "...the typical American classroom, at any level, is oriented toward competitive individualism" (1997, p. 137). Competitive individualism, right or wrong, is a basic tenet of middle- to upper-class white culture. Many parents and students are opposed to the use of cooperative learning and our current emphasis on grades is definitely not in keeping with the objective of a classroom working together toward a common goal. Also, teachers need to be given the tools to teach about a variety of cultures. This is not a simple matter as educators teach best when they know their subject matter and feel competent, and without appropriate training, teachers may be out of their comfort zone. This is not to suggest that the authors' suggestions are not valid or even feasible, only that the changes called for are dramatic and not easily attained.

Both the Davidson and Kramer (1997) and the Gross (1993) articles address the importance of professional development and variables to be considered in this area.

Archibald (1995) undertook a longitudinal study to compile data related to school choice and magnet school outcomes. The longitudinal design comparing second and fifth grade scores was conducted to try and minimize the confounding influences of self-selection bias and focus on achievement. Sample sizes of 3,890 (Cohort 1) and 4,680 (Cohort 2) Milwaukee Public School (MPS) students were used to expand the sample size and increase generalizability of the results. The dependent variable was the fifth grade mathematics and reading scores for the Iowa Test of Basic Skills. The main independent variable was the magnet variable. Other independent variables were transfer status, free lunch status (used as a socioeconomic status control variable), second grade achievement, and race. Multivariate linear regression analysis was employed on the students' Normal Curve Equivalent (NCE) scores.

The study found that students in the magnet schools scored significantly higher in both reading and mathematics than both the transfer and non-transfer students. The study also shows that the non-transfer students' scores were higher than the transfer students' scores, although when these groups were broken down by race, there was very little difference between the scores. When the author analyzed the results controlling for prior achievement and free lunch status, the magnet school students showed an improvement of an average of three NCE points while the transfer students had lower scores of one to two NCEs. It was interesting to note that students who are not eligible for free lunch will on average outscore their full free lunch counterparts by five to six NCE points, equated on prior achievement.

Archibald's study clearly shows that the scores of magnet school students are higher, but further analysis was deemed necessary to determine why. In a previous study, the author had found that there was not a significant difference between the class size in magnet and non-magnet schools (27 versus 28 students on average) and that there are not significant resource differences between magnet and non-magnet schools. Other differences suggested are level of parental involvement, school climate, quality of teachers, and student self-selection. The author calls for further research to determine the factors that may account for differential performance. Archibald states that "this study adds evidence to the proposition that school choice policies create conditions which pay off in higher student achievement" (p. 167).

There appears to be a contradiction inherent in the author's last statement. Assuming that transfer students choose to go to school outside of their neighborhood, why are their test scores lower that their non-transfer counterparts? Even though the difference is not large, the scores of black non-transfer students are consistently higher than the black transfer students. The author states that the majority of black transfer students are from the racially isolated inner city region of Milwaukee and that there are about fifteen schools in the inner city that have few or no non-black children. It would be interesting to see statistics comparing student scores from these schools with scores of transfer students from the same area and see if any patterns emerge.

The author's purpose for this study was to examine the effects of school choice, and, more specifically, magnet schools' impact on student achievement. His data revealed some very disturbing statistics which he did not address. Table 3 indicated the mean fifth-grade NCE scores for magnet, transfer, and non-transfer students broken down by race. In all categories, white students outscored their black counterparts by thirteen to nineteen NCE points with the largest differences in the magnet school students. Not one subgroup of black students scored above the mean of fifty, whereas all subgroups of white students scored above. Also, the scores of black magnet school students did not have as large an increase over the scores of their black non-magnet school counterparts when compared to the scores of the white students. The larger question here seems to be: Why are the scores of black students in the same school settings significantly lower than the scores of their white counterparts, and what can be done to improve their performance?

The ethnographic study performed by Walker and McCoy (1997) of seventeen African American students selected from a high school in a small city with an enrollment of 1250 is necessarily limited. The authors specify that thirty percent of the school's population is African American but nothing is told about the socioeconomic makeup of the school or the students interviewed. Some important points did surface from the interviews, however more research is necessary to determine the generalizability of the findings.

It was obvious from the interviews of these students that the teacher did play an important role in how the students felt about math class. The students' perceptions of whether or not their teacher cares about them seems very important to them. Teacher characteristics cited which indicated teacher interest included sitting African American students in the front of the classroom, encouraging them to participate and not be silent, and relating to the students as individuals. The students who feel they have a personal relationship with their teacher are more confident and seem to work harder in the classroom. At this school there is a black math teacher of whom the students were particularly fond. Although the students did not berate white teachers, their comments indicated that they felt many white teachers are unable to relate to them culturally, and some students felt that white teachers are more interested in good behavior than in the African American students as individuals. If they behaved well they were virtually left alone, whereas if they misbehaved, they received attention from the teacher, albeit negative attention.

The authors also found a correlation between parental involvement and mathematics achievement. Students who were performing well in their math classes cited their parents as having a positive influence on their school achievement during the interviews. Three students who were failing math either didn't mention any family members as positive influences or berated them for their lack of encouragement.

This study helps to substantiate the findings of other research that has been done in this area. The authors' interviews indicate that:

- The classroom must be a positive setting where there is genuine caring and students are expected to learn.
- Family support is an integral factor in student achievement.
- African American students may be stereotyped by their athletic abilities with school achievement taking a second place.
- African American students may fear standardized tests and develop an apathetic attitude as a defense mechanism. This supports the notion of learned helplessness.
- Many African American students may not realize the potential avenues that a solid mathematics background opens up for their future.

It is good to explore the opinions of African American students in our search for answers. Determining how students feel about science/mathematics and their school experiences related to these areas may give educators insight into how to include African American students in the academic community. It would be helpful to see this ethnographic study expanded to students in inner city urban schools and also high school students in the pre-algebra level.

Tobias (1992) points out that his recommendations for improving mathematical and science achievement are applicable to all students but are especially crucial for African American students whose achievement is lagging far behind. Tobias feels that teacher education programs in mathematics and science have not changed significantly, but that strides are being made on the level of in-service teacher training. It is important that teachers are taught in the methods in which they will be expected to teach. They need extensive experience with problem solving in math and science.

Another important aspect of improving mathematics and science achievement is making these subjects relevant to students' everyday lives. Even though it is obvious to the teacher that mathematics and science are pervasive in our lives, students must be shown and taught this concept. The use of projects, activities, and games to highlight this makes math more interesting and more meaningful. Arguably the most important change to be made is in raising the self-esteem of the African American student in the area of mathematics and science. This particular goal can be accomplished by providing students with as many opportunities as possible to succeed in computation, problem solving, and comprehension within a structured environment. Mathematics and science should be taught in progressive steps with constant monitoring of students' mastery. African American students must also be taught about the significant original contributions made by mathematicians and scientists of their own race and should be provided with classroom role models.

The suggestions that Tobias makes are relevant and important. One of the most frequently asked questions in the middle school math classroom is "Why do I have to learn this and when will I use this knowledge?" Rather than answering this question, teachers need to show students the relevance to their everyday lives of the content being studied. Projects and activities that are meaningful to the students should be used to teach the curriculum rather than teaching topics in isolation.

Tobias indicates that much has been written about the effect of teacher expectations on student achievement, but equally important is students' expectation of their own capability. It is imperative that teachers work to raise students' mathematical self-esteem, as the accepted popular convention is that certain individuals are 'born' to be good in math and science and the rest of us are not genetically predisposed. Students of all races and genders need to be provided with role models disproving this myth.

Tobias' recommendations could help improve the mathematics and science achievement of all students. However, to assure the success of African American students, we must concentrate on getting highly qualified math and science teachers into our urban and economically disadvantaged schools.

Robinson (1996) supports the Tobias position. Although writing in the journal *Urban Education*, Robinson's premise is that the future of our nation and its ability to compete in a technological society are contingent on giving all students the opportunity and ability to be competent in mathematics and science. The author specifically targets the need for reform in our nation's urban schools. Robinson cites data compiled from the 1992 National Assessment of Educational Progress (NAEP) exams which indicated that students in disadvantaged urban areas consistently achieved significantly lower proficiency levels than the national averages at all grade levels tested. Robinson suggests that one of the causes of their subpar performance is the effects of being born into poverty. A secondary cause indicated is the lower expectations for these students held by the education community.

Robinson expresses three guiding principles that must be met for effective reform in science/mathematics achievement in the urban setting. First, the social and economic poverty in urban areas must be addressed. Schools alone cannot take on this task; the coordination of social agencies and the entire community is imperative. Secondly, all students should be expected to learn and to achieve at high levels. The mathematics and science curriculum for urban students should be challenging and exhibit high standards. If the standards and expectations are raised for these students, achievement will be raised. Thirdly, assessment reform is necessary. Robinson states that the purpose of assessment should be to enhance student achievement. Assessments should evaluate the effectiveness of the curriculum, highlight roadblocks to learning, and encourage higher-order thinking skills. When used correctly, assessment should also elevate student confidence.

The need for research specifically related to the mathematics achievement of African American students in the United States is highlighted by disturbing and increasingly dismal statistics. Over one-third of African American students drop out of school before finishing high school. There are more African American males in jail than in college, and African American males outnumber whites in jail. In the 1990's, civil rights leaders argued that mathematical literacy is necessary for the advancement of African Americans, and minority students cannot continue to be tracked out of gatekeeper classes such as algebra and calculus. Giving underrepresented students access to higher level math increases their chance for educational and economic success. (Ladson-Billings, 1997)

Ladson-Billings' research (1997) has focused on successful teachers of African American students. She believes that in order to change the achievement levels of African American students, the pedagogy must be changed. Ladson-Billings encountered a "pedagogy of poverty" in her research - students being taught math through routine teaching acts that failed to engage or interest them. She found that the teachers who taught in this manner tended to possess one or more of the following characteristics:

- they themselves did not perform well in school,
- they approach teaching systematically or as a set of rules,
- their main goal is to manage or control their students,
- they hold low expectations for their students, and
- they are unlikely to pursue intellectual pursuits themselves and are unwilling or unable to change their teaching techniques.

In contrast, exemplary teachers of mathematics develop a pedagogy designed to ensure high mathematics achievement among African American students. Following are principles necessary to this pedagogy:

- Students are expected to display high levels of competence and to succeed.
- Teachers use students' prior knowledge to build on to learn new knowledge.
- Teachers and students are engaged in mathematics learning during the entire class period.
- All students are challenged and expected to perform at levels traditionally considered to be beyond their capability.
- Teachers know their students well and form strong relationships with them.

The teaching practices necessary for high achievement in mathematics advocated by Ladson-Billings should apply to all students. The Third International Mathematics and Science Study (TIMSS) (U.S. Office of Education, 1996) revealed that U.S. school children continue to lag behind students in other highly technological nations in mathematics and science achievement. The reasons for these lags are multiple - teachers without adequate preparation in mathematics and science, unimaginative approaches to teaching, teacher misassignment, poorly constructed textbooks (p. 698). These inhibitors to mathematics achievement can be found in most school districts to differing extents but are more likely to be pervasive in urban, low-income school districts. Ladson-Billings makes a good argument for what needs to be done and what our math classrooms should look like, but does not give any specific strategies for how we should get there. Instead, she calls for further research and documentation of successful practices of teaching mathematics to African American students.

Factors associated with under-representation of African Americans in mathematics and science is reported in *Journal of Negro Education* by Powell (1990). Many African Americans perceive themselves as incompetent in the areas of mathematics and science. Society's views of scientists and mathematicians as highly intellectual, strange, and socially inept make it easy for students to justify not wanting to go into such careers. African American college students are over represented in careers such as education, social sciences, and humanities which traditionally are lower-income occupations. Powell questions whether this is due to cultural differences in what is valued or perceived incompetence in fields calling for mathematics and

science. The author hypothesizes the latter, although she acknowledges the lack of scientific research in this area.

According to Powell a widely held view "that the mean IQ of African Americans falls in the low average range" has led to lower expectations for this cultural group in subject areas perceived to be highly intellectual by whites and African Americans alike. Learned helplessness is a self-fulfilling prophecy. Scientific studies have shown that many African American students receive poor preparation in mathematics and science early in their careers and therefore experience repeated failure and do not master the basic concepts of these subjects. "Upon encountering continuous failure individuals may stop trying, not only in the setting where their failure was initially elicited but also in other settings where there might be a better chance for success" (1990, p. 294).

The author also discusses two other factors associated with learned helplessness. The first is overcrowded conditions in the home. Powell states that "When there is an absence of privacy due to the presence of too many people in the household, individuals tend to develop a sense of lack of control..." (p. 295). She also relates this to large class size and lack of individual attention. The other causal factor discussed is uncontrollable noise. Since mathematics and science are more complex subjects, noise pollution seems to negatively impact learning in these subjects to a greater extent.

Powell recommends several strategies to counteract the detrimental effects of persistent failure, crowded living and learning conditions, and noise pollution. First and foremost, African American students must be given the opportunity to succeed on difficult math and science tasks. Clinical studies have shown that the pairing of aversive and pleasant stimuli will help improve the symptoms of helplessness over a period of time. Powell also recommends that mathematics and science classrooms should provide environments that are quiet, pleasant, and orderly. It is also important that there is optimal student-teacher interaction. Powell feels it is essential that high school counselors encourage students to take a full load of mathematics and science courses. Finally, the author advocates that funding be made available for further research related to African American career choices. In regards to achievement variables, Powell's contribution seems to be associated with "learned helplessness" and having high expectations for students.

Malloy (1997) indicates the results of the 1992 NAEP showed some improvement in the computational skills of African American students, but their performance still lags far behind that of the general population. Learning mathematics necessitates becoming part of the mathematics community and valuing the importance of thinking and doing math. Educators need to study the unique characteristics of the African American culture in general and African American students in particular to

make instructional recommendations for including these students in the mathematics community.

Most African Americans have strong ties to their culture, which has an effect on their mathematics learning. Mainstream culture shapes students' perceptions of themselves and their abilities. Malloy (1997) points out that just as many African Americans have exceptional athletic abilities and positive social reinforcement encourages dreams of their being the next Michael Jordan, there has been an equal negative reinforcement of the science and mathematics achievement of African American students. The media continually shows the achievement gap between these students and the general population resulting in African American children being tracked into lower-level math classes early in their schooling. Negative perceptions lead to lower expectations of mathematics abilities by the students, their parents, and society as a whole. (Malloy, 1997)

Educators must not allow African American students to dissociate themselves from the mathematics learning process. By teaching African American students on the basis of what is known about their culture and preferences for learning Malloy indicates, hopefully, science and mathematics achievement will be improved and expectations raised. Malloy (1997) indicates that African American students learn best through direct contact with their teachers and peers. Therefore cooperative rather than competitive learning is an effective teaching strategy. It is also important that interaction, trust, active engagement, and meaningful relationships are all part of the math classroom, and teachers should use student life experiences in their instruction. Giving African American students' opportunities to express themselves through writing and oral presentations is also consistent with their culture and learning style.

A recent study of African American students who were successful in mathematics despite being a part of a community where low achievement was the norm revealed the following characteristics: 1) positive family, school, and community interaction; 2) students sought help when they encountered difficulties; 3) high self-esteem and self-efficacy and a desire for mathematics achievement; and 4) participation in activities that opened up opportunities. Malloy recommends that math and science educators integrate culturally responsive educational practices into their classrooms based on empirical findings, and then study the effects of these changes on African American student achievement. To include African American students in the science/mathematics community, we must change how they perceive their abilities and teach them in a manner compatible with their learning styles.

It is interesting but not surprising that studies of skills needed to be effective problem solvers undertaken over the last twenty years have focused on majority students. Skills identified were basic computational skills, analytical reasoning

ability, field independence, and self-esteem. Research on learning preferences of African American students show that they prefer holistic reasoning to analytical reasoning and tend to be field dependent. African Americans' self-esteem in the area of science/mathematics is generally low due to lower expectations of parents, schools, and the community as a whole. It is easy to see that the traditional methods of teaching using an expository style that is linear and analytical is in direct conflict with the learning style of many African American students. Science/mathematics educators need to encourage diverse methods of approaching and solving problems. Mathematics also needs to have meaning for all students so that they can construct scientific/mathematical knowledge based on experiences that are relevant to their lives. Malloy indicates that the teaching practices encouraged by the National Council of Teachers of Mathematics (NCTM) are necessary to improve mathematics achievement of all United States students. These practices help African American students also, but specific strategies must be developed to assure that African American students feel capable and become an integral force in the mathematics community.

In summary, it seems that student demographics (specifically, gender and ethnicity), classroom climate, pedagogical practice, mathematics and science curriculum, teacher professional development and aligned curriculum coupled with appropriate assessment concerns constitute the primary areas for variable identification.

Researchers' Responses to the Theory of Systemic Change
NSF's Primary Change Driver: Standards-Based Curricula

Both content and pedagogical changes are implicated in the theory of standards-based curriculum reform. The success potential of USI is related to a level of coherence between the logic and intentions of standards-based content and pedagogical approaches. A key concern is whether the standards dictate sensible behavior at the classroom level. What indicators define successful implementation of standards-based curriculum? What measures best reflect individual student achievement? What indicators define success in school buildings and in school districts? Responses to these questions drive strategic interactions that determine systemic reactions which shape how teaching and learning occur. Responses to these questions also ultimately express values, which are embodied in ends sought by reform (Howe and Moses, 1999). The answers to these questions might also signal critical differences in approaches advocated by various stake-holders.

The mandate to set more rigorous standards originated with "end" concerns about promoting economic competitiveness. To garner intellectual capital, American students must rank among the best educated in the world. Students' scores on standardized tests are the traditional measures that indicate whether American

schools are successful in covering selected mathematics and science topics with the same depth and breadth as the topics are covered in the schools of competitor nations. At the state level, standards-aligned assessments monitor students' abilities to demonstrate content knowledge by performing more complex evaluation tasks. When test scores rise, schools are labeled successful; when test scores stagnate or decline, schools are labeled as failures. Failing students must spend more time on tasks, by attending school for longer periods. Failing schools require staff development, reorganization, or reconstitution. In this paradigm, the curriculum is fixed and performance on standardized tests indicates students' achievement, as a reflection of system accountability (Hershberg, 1999).

Standards-based education in another of its earliest conceptualizations established development of thinking and problem-solving abilities as the primary objective of education, providing mechanisms for "top-down support for bottom-up reform" (Darling-Hammond, 1994, p.18). Acknowledging application and authentic performance as the crucial by-products of the process, many reform advocates, in this tradition, assign priority to reorientation of the best example of teaching from teacher, as expert, to student, as questioner. Reform advocates, particularly faculty working within university schools of education, believe that American children will think and solve complex problems more effectively, if schools generally require more intellectually demanding work and expect higher performance (Cohen, 1995). Many education faculty researchers support approaches established by a line of education Progressives who emphasize development of complex cognitive and performance abilities that are demonstrated in a variety of ways, including authentic demonstrations, in non-test contexts (Dewey, 1916; Bloom, Hastings, & Madaus, 1971). In this paradigm, students and teachers interact as problem-solvers. Knowledge is not fixed, but is discovered through interactions with many types of experiences, including solving non-routine and open-ended problems (D'Ambrosio, Johnson & Hobbs, 1995). Student work demonstrates achievement measured against context embedded performance standards, which students receive as rubrics or scoring guides to guide their work (Seidel, 1991; Schwarz, 1994).

Following the lead of NCTM and NRC, the NSF theory of reform juxtaposed content-based standards and assessments with inquiry learning. There can exist tension in this "marriage." Central to the shift from teacher-expert approaches to student- and teacher-problem-solver approaches lie key cultural issues, such as what body of information constitutes defining knowledge. In the Progressive tradition, many educators believe that schools should facilitate self-affirming connections between students and curriculum (schooling experiences) as opposed to relating learning to knowledge and schooling customs established in earlier periods to reflect dominant cultural beliefs and purposes (Giroux, 1997; Apple, 1983; Friere, 1973; Dewey, 1916).

In contrast, Western traditionalists believe that education should shape the ideas and ideals of American citizens to reflect dominant cultural values (Sowell, 1992; Hirsch, 1987; Bloom, 1987). Content-based reform asserts very specific curricular topics, as well as types and levels of information required. Anticipating debate about the nature of curricular content "within the context of content-driven systemic reform," systemic reform strategists consider state adopted "frameworks" as focal points for constructive public deliberation.

The legitimacy and effectiveness of a systemic curricular approach will ultimately rest in the ability of the system to establish challenging curricular goals while striking a creative balance between the common culture and needs of the whole society on the one hand and the diverse perspectives, needs, and histories of subgroups and individuals on the other.
(O' Day and Smith, 1993 p. 294)

Clarity of the NSF Reform Vision: The Content-Based Systemic Reform Model Applied in Urban Contexts

The goal is to achieve wide spread support for expecting all students to perform at high levels. Teaching for and learning with understanding are behaviors described by the National Science Foundation's consultants for systemic reform, as "demonstrably effective pedagogical concepts... 'inquiry-based' ...which relieve students from the ultimately unproductive burden of rote learning" (Westat*McKenzie, October, 1998). This explanation characterizes the NSF's position regarding pedagogy. Consistent with assumptions of Progressive educators, it posits development of critical thinking and problem-solving abilities as critical outcomes. At the same time, NSF embraced assumptions that "deep understanding of academic content" is a critical prerequisite for complex problem solving (O'Day and Smith, 1993, p. 262). Again, there are competing ideas about how curriculum and assessment standards should be set.

America's competitor industrialized nations sponsor national curricula that feature coherent, integrated, centralized policies. American education policies are set at the state level, resulting in the lack of coherent, centralized policies. The systemic reform model supports a unique common approach to state-by-state design of coordinated curriculum frameworks, standards, and assessments. Fuhrman, Elmore and Massell (1993) define policy integration, coordination and alignment towards a set of specific outcomes, as major features of systemic reform. With the USI initiative, NSF implicitly adopted the theory of alignment, using process and results "drivers," as systemic change components to frame expectations for work in urban districts. Alignment of resources, policies, and behavior as a fundamental activity for systemic efforts, in theory, facilitates adoption and sustained use of standards-based curricula in science and mathematics.

Consistent with emerging state systemic reform approaches, urban systemic reform focuses state reform expectations on urban school districts to achieve "a reduction in

attainment differences between traditionally under served K-12 students and their peers" (Westat*McKenzie, September 1998, p. 10). The Council of Chief State School Officers (CCSSO) has invested in mechanisms to assist schools in monitoring implementation of curriculum and strategies designed to achieve the target reduction in attainment differences. The Survey of Enacted Curriculum (SEC) collects data on mathematics and science curriculum and teaching practices. SEC surveys teachers to determine what they taught, for how long, and with which methods (Blank and Kim, 2000). Analysis of survey results will document curriculum changes associated with systemic reform efforts at state and urban district levels.

In addition to monitoring teacher reported changes in what is taught and how, NSF has commissioned research to determine the alignment of standards and assessments. The method of alignment study used at the state level will likely advise a similar process for reviewing alignment of urban district curricula with state standards. Researchers defined four alignment criteria to reflect the range of issues addressed by the standards. These include Content Focus, Articulation Across Grades and Ages, Equity and Fairness, Pedagogical Implications (Webb, 1999). Recently released results of a four state alignment study, indicate that the study design facilitated review and coding responses for only four of the five attributes of only one criterion—Content Focus. The researchers noted plans to review over time the fifth content attribute, Dispositional Consonance, defined as agreement in attention to students' attitudes and beliefs. Current study results do not reflect review of alignment of additional criteria, including Pedagogical Implications, with attributes related to pedagogy, such as engaging students and use of technology, materials, and tools (Webb, 1999).

The Policy Driver: Backbone of Systemic Change

Based on experience with State Systemic Initiatives, researchers have found that "in policy discussion, it frequently appears that reforms consist only of standards and assessments. Other central components, like support for classroom change through focused and enhanced teacher education and professional development, are less visible" (Fuhrman, 1995, p. 4-5). The most frequently heard message is that setting standards and measuring achievement will lead to better teaching and learning. Less attention has been paid to the formulation of policy to guide scaling-up from good examples (Hess, 1998).

Researchers appear to believe that school funding and desegregation have generally been ignored as equity issues. An additive approach is in evidence; new practices and new policies are discussed, while old policies remain on the books (Fuhrman, 1995).

Success has been reported for reform efforts that facilitate school-level networks that unite volunteer schools in collaborative efforts. Researchers report that networking, as a concept, holds promise, because membership promotes access to knowledge for change. Knowledge about change and public information about the challenges of reform have been useful in building necessary public support (Fuhrman, 1995). Public support for sustained, long-term reform activity is important, as research indicates that pressing for immediate results may not provide the best conditions for implementing desired change in volatile urban environments (Hess, 1998).

Additional research (Hirth, 1996; Fuhrman, 1995) indicates that systemic reform is fundamentally related to state school finance policy changes. Effective reform will be evidenced in specific allocations of resources for institutionalizing change and should clearly define how available resources are realigned to accomplish change. Perhaps, most significantly, there should be evidence of efforts to achieve greater equity in state support of urban schools where students and communities have more need.

A study by Grissmer, Flanagan and Williamson (1998) suggests that neglect of school finance policy reform might constitute the "Achilles heel" of systemic reform efforts, in light of empirical data suggesting that funding to schools and disadvantaged families influences educational outcomes. NAEP results indicate score increases of disadvantaged minorities and resource increases targeted to that population from the 1960's to the early 1990's.

- Evidence that effective increases in real resources from 1967-1991 available to boost achievement of regular students has been markedly overestimated due to failure to correct for inflation and the diversion of resources to students with disabilities [in previous research]
- Evidence that the more limited real resources available to increase achievement scores from the late 1960's to the early 1990's was disproportionately targeted at minority and lower income children
- Evidence that minority and less advantaged children have made substantial gains in test scores in the 1970 to 1990 period, while more advantaged students have made only small gains
- Evidence that the timing of score gains of minority children seem to be related to both the civil rights and war on poverty efforts as well as declines in class size (Grissmer, Flanagan, and Williamson, 1998, p. 2).

Policy also concerns state and local alignment of "what is taught" with "what is assessed", with "how teachers are prepared and supported," as well as with "how teachers are evaluated." NSF's approach to systemic reform reflects broad agreement on what should constitute curriculum (content standards), and it avoids

constricting local options for how alignment is achieved. This approach encourages diverse communities to focus on local realities (Knapp, 1997; Fuhrman, 1995; Westat*McKenzie, September, 1998).

Data collected for this study, from each affected district, then, reasonably seek evidence that local school boards and communities are addressing eight questions related to policy alignment:

1. To what extent has the local district adopted national/state mathematics and science standards?
2. How are state and local systems insuring desegregated, equity-based access to high quality science and mathematics teaching and learning?
3. What local district policy changes indicate the shift to standards-aligned practices in student evaluation, teacher selection, and teacher support?
4. What local district policy guides school level voluntary networks for professional development and skills sharing?
5. What local district policy changes indicate the shift to standards-aligned practices in text book selection and other curriculum shaping activities, including use of informal and enrichment learning resources, such as science centers, zoos, etc.?
6. What local district policy changes indicate new or stronger relationships with university programs for teacher preparation and recruitment?
7. What policy additions or changes support development of major advocacy and public information relationships with key local and state stakeholders?
8. What policy changes indicate a monitoring approach that continues during a time period that realistically allows the system to embrace genuine change.

The Outcome Drivers: Where Policy Meets Implementation Reality

The object of change is improved student achievement and competitive student outcomes in urban schools. While inevitably this study must view by individual district achievements, based on the common set of variables associated with the six NSF change drivers, the challenge of the current study is to go beyond case by case descriptions of reform implementations in states and urban districts (Knapp, 1997). This study attempts documentation of specific overarching common variables that indicate movement towards the teaching and learning reforms that hypothetically contribute to desired student achievement outcomes. The systemic reform initiative challenged school districts and communities to research and conceptualize (envision) different content and different ways of interacting with content, to craft

policies that promise to guide long-term improvements in system supports for the new vision, and to fully implement change. The study of each community's response requires close inspection of policy, its translation in day-to-day practice, and student outcomes defined by quantitative and qualitative indictors.

[The reform vision] is one that emphasizes the learner's understanding of central ideas and processes; application of ideas and skills to non-routine, complex problems; in-depth immersion in important themes and topics, rather than exhaustive coverage of materials; active mental (and often physical) engagement with scientific phenomena; exposure to authentic, real-world phenomena, problems, and scientific activities (Knapp, 1997, p.6; Thompson, Spillane, & Cohen, 1994 as referenced by Knapp).

Knapp (1997) characterizes NSF's vision for teaching and learning as "elaborate and ambitious," and he delineates critical realities from which to view implementation progress. These critical realities are discussed below, as they also surface in the research and reports of science and mathematics educators, as well as in the studies and policy analyses reported by urban education experts, as underlying factors in viewing success and progress in urban school reform implementation.

EVOLVING CHAIN OF INFLUENCE IN SYSTEMIC REFORM

Changing Ideas about Science, Mathematics, Pedagogy, and Learners

A report released in 1998 by the U.S. Department of Education analyzes data from the Third International Mathematics and Science Study (TIMSS). Researchers conclude that the relatively poor performance of U.S. students on international mathematics and science achievement tests are related to differences in curriculum (content) and pedagogy (process) between U.S. schools and schools in competing nations, such as Japan and Germany.

Other curriculum specialists, however, question the utility of TIMSS comparisons specifically those related to curriculum, because the TIMSS data generalizes to the American system, and it does not account for varying results, given the absence of a national U.S. curriculum (Usiskin, 1998). Usiskin (1998) also questions studies of instructional approaches, which he believes yield little that can be replicated. Instead, he favors studies of materials, such as textbooks, and definitive studies of student performance when NCTM endorsed curriculum (standards) and problem-solving approaches (pedagogy) are used.

Interestingly, standards-based teaching as defined by Usiskin (1998) advocates instruction that fosters knowledge of underlying mathematical concepts and the ability to apply concepts. Usiskin appears to believe that critical problem solving ability will result from use of specific curriculum materials and University of Chicago School Mathematics Project (UCSMP) texts, published by Prentice Hall.

Among the TIMSS study's major findings are the following:

- *U.S. schools compare poorly by doing less with more*
- *Science and mathematics curricula and textbooks are too diffused, unfocused, and not challenging.*
- *American courses include more topics covered and less time is spent on each topic, resulting in reteaching topics, but providing too little of any one thing.*
- *The mathematics curriculum fosters less thought, less achievement. American schools teach procedures, not understanding.*
- *U.S. teachers rarely develop mathematical concepts in instruction.*

(Forgione & Gonzales, 1998, p. 6-19)

In contrast to NCTM's support for a single or defined text adoption, the School Science and Mathematics Association (SSMA) takes a different approach to identify

major curriculum tools. SSMA supported development of an instructional materials evaluation system, in relationship to Virginia's State Systemic Reform effort. Representatives from eleven states guided development of thirteen (13) criteria for selection of instructional materials in science and mathematics, including Analytic and Likert instruments to measure the criteria (Koontz, 1996).

*Such a learning environment... strive[s] for universal acceptance and classroom implementation of such demonstrably effective pedagogical concepts as 'hands-on' and 'inquiry-based' education which relieve students from the ultimately unproductive burden of rote learning (Westat*McKenzie, October 1998, p.5).*

In other research, texts and instrumentation are subordinate concerns. As noted by Usiskin (1998), much mathematics (science) education research is concerned with instructional techniques (p. 9). Metz (1995) examined children's ability to engage the inquiry process. She concluded that meaning and application ability can be fostered if students have early and frequent opportunities to pose questions, gather and interpret data, and revise their own theories.

Inquiry, as a primary teaching/learning approach, is a significant component of NSF's implicit theory of standards-based reform, and it signals the importance of orienting thinking about science, mathematics, and pedagogy to make inquiry learning opportunities available to a range of learners. NSF's advocacy for every school's use of state and national standards to create "high quality" teaching/learning environments is a central expectation of the Urban Systemic Initiative.

Assembling Pieces of a Complex Puzzle

Only by providing schools and parents with a choice of valid, well-supported models of schooling can we make the change process manageable for school personnel, and satisfy the conflicting demands of the public. If we do not create a gallery of clear models, the individual puzzles will remain blurred and grow increasingly fractured (Doss, 1998, p. 594).

Educational research provides a rich backdrop for engaging pedagogical change. There might, perhaps, exist so much theory and recommended strategy that the most skillful reform leaders will first own a personal commitment to a theoretical framework. Still more effective are those frameworks that provide concrete examples of how they work. Adoption of inquiry as a systematic instructional approach adds a number of "pieces" to an already complex set of instructional considerations.

Different ideological frameworks are implicated in various and even similar instructional approaches. Constructivists' ideas are central to advocacy for investigation, as a pedagogical approach. Constructivists' ideas follow both cognitive and social orientations. Cognitivists are most concerned with

learners' interactions with the physical world--manipulation of objects and hands-on experiences. The content-based standards-derived inquiry advocated by the science and mathematics organizations responsible for developing the content standards is based on Cognitive Constructivist ideas. (AAAS, 1989; NCTM, 1989)

Social Constructivists believe that understanding and learning occur through socially mediated events and that social interaction, the cultural context, and language use are fundamental to thought. "Educators and researchers ... are interested in how students think about scientific problems and how they use their own understandings of scientific processes to build conceptual models." For these researchers discourse in science classrooms indicates what is learned (Richmond and Striley, 1996, p. 839). Science/mathematics literacy, according to this line of reasoning, is reflected when students have the ability to develop problem-solving tools, including observation, reflection, and assimilation of knowledge into their own models or theories about phenomena in the physical world. This ownership of understanding or meaning-making is believed to contribute significantly to student performance, and it poses additional issues in systemic reform for urban schools, given the cultural and linguistic diversity of students in those schools (Garcia & Gonzalez, 1995).

Students' attitudes are also believed to influence achievement results, and might be considered the "buy-in" factor which is associated with perceptions of efficacy (Greenfield, 1996). The work to "hook" students on science involves "incorporating students' culture and language in science teaching, orientation of science pedagogy toward reciprocal interaction, and teacher behavior that empowers student curiosity (Atwater, 1996, p. 831). Students "buy-in" when teachers trust and challenge them to find answers, and relate information to community or societal realities. When instruction requires students to ask and answer questions, teachers incubate scientific habits of mind. Students "buy-in" when they are interested in what they study and perceive knowledge to have utility in their life planning. Sociology studies describe urban student motivation in research documenting places of hope for inner-city youth, where students welcome responsibility and enthusiastically engage in activities that support their escape from inner-city despair and reshape their life chances (Delgado-Gaitan, 1993; McCaleb, 1994; McLaughlin, Irby, & Langman, 1994; Wehlage et al., 1989).

> *...if appropriate practices are consistent over a long period of time, children can and do learn to enjoy and value mathematics. There is a building body of evidence that indicates the larger, more general goals of schooling can be restructured and reinvented with a fair degree of success so that the school culture becomes conducive for student learning and motivation. ...evidence that classroom practice can be positively reinvented so that the culture of the classroom can become conducive for learning and enjoying mathematics.*
> *(Maehr & Anderman, 1993, in Middleton & Spanias, 1999, p. 85-87)*

An analysis of research on student achievement motivation, reported by Middleton and Spanias (1999), finds that "achievement motivation in mathematics [science] is highly influenced by instructional practices" (p.85).

The concept of best practices acknowledges the interrelationship of social, cultural, historical and psychological factors. Schools function in communities, and effective practices are based on models and research linking teaching and learning to community realities. "The situation-specific nature of the kind of teaching and learning envisioned by school reformers is the key challenge for teachers' professional development...success...ultimately turns on teachers' success in ...learning the skills and perspectives assumed by the new visions of practice and unlearning the practices and beliefs about instruction that have dominated their professional lives to date. ...teaching for understanding relies on teachers' abilities to see complex subject matter from the perspectives of diverse students" (Darling-Hammond, 1995, p. 597).

Best practices engage students (Hilliard, 1989). Students are more successful when they are more engaged. Students are best engaged when their teachers and schools see the education enterprise from the perspective of the students and their parents, implicating the need for "new teacher perspectives (Keith, 1995; Liebling, 1996)." The reform agenda, therefore, must include new active local community relationships that cast science and mathematics learning as important issues, especially for resource poor communities (Ramsey, 1995).

Standards-informed, emergent ideas about teaching and learning mathematics and science suggest several systemic reform challenges: changing student attitudes about science, changing teachers' perceptions of what works in teaching science, and changing teachers' perceptions of who can be successful in performing in open-ended investigatory tasks. Outcomes indicators which serve as validation measures for reform, according to researchers, will make school success in science, mathematics, and technology curricula a key criterion. Research suggests that effective curricula are accessible and useful in the lives of students with the "range of abilities and dispositions that a robust democratic society requires." Effective curricula lead to "circumstances of richly textured educational environments guided by caring, competent, and professional teachers" (Goodlad, 1998, p. 670; Darling-Hammond, 1994; Kyle, 1998; Wiggins & McTighe, 1998).

System Requirements and Regulators of Practice: Defining "High Quality" is Important

Defining "high quality," by leveling appropriate expectations for performance, appears a critical challenge. Performance expectations are visible in assessment

measures, and assessment, therefore, must be examined in light of some conceptualization of the teaching and learning behavior that constitutes "high quality." If, as NSF documents suggest, "high quality," means that "learning is a process in which youngsters are active participants in the acquisition and construction of knowledge" (Westat*McKenzie, September 1998, p. 9), then reasonable assessment modes will reflect students and learning as active and interactive agents (Kyle, 1997). Otherwise, imposing traditional standardized performance measures "obstructs efforts to improve science education," and runs contrary to objectives for engaging students in rigorous intellectual activities that foster meaning and contribute to understanding (Kyle, 1997).

Meeting standards for high quality, then, might occur if systems develop mechanisms for viewing or measuring success in relationship to authentic indications of what students can do--displays of outstanding student work which have been noted as "oddly missing from most American schools and from most of the arguments about how to repair them" (Cohen, 1995, p. 751). Without an understanding of the range of results possible from an instructional program, neither consumers (parents, students, community stake-holders) nor regulators (school boards, school personnel) can develop practical/transforming behavior or expectations for results, beyond standardized test scores (Cohen, 1995 p.751).

Adoption of appropriate assessment measures is dependent on development of such measures. Researchers assert that scientific [mathematical] inquiry has resisted analysis, but studies by Cognitive psychologists and science educators should result in progress in defining instruments and approaches (Germann, Aram, Odom, and Burke, 1996). Several lines of reasoning will influence development of assessment protocols.

Cognitivists view the key skill in science investigation as the ability to distinguish and coordinate the relationship between theory and evidence. Researchers have determined that young children do not differentiate an explanation from data or evidence that might support or refute the explanation. These studies indicate that children's prior knowledge significantly influences hypothesis formulation and experiment design (Kuhn et al., 1988 in Germann et al., 1996).

Other Cognitivists consider prior knowledge an essential link for adding new knowledge. In this research, process is emphasized and requires activation of long term memory (prior knowledge) to represent the problem, search for remembered knowledge as the model for fashioning solutions and evaluating the chosen solution (Klahr & Dunbar, 1988 in Germann et al., 1996).

Science education research has focused on the development of process skills, including posing questions, hypothesis formulation, variable identification and

description, experiment design, data collection, manipulation and analysis. Science educators believe that practical involvement and skills use result in increased proficiency, and conclude that assessment should be consistent with instruction and learning (Germann et al., 1996). Research in this area has shown that students have inadequate experience for proficient performance on assessments of laboratory process skills (Germann et al., 1996). The assessment protocols associated with this research do not discount open experimental inquiries where students pursue their own causal questions and pursue independent reasoning modes. While these more authentic protocols are useful in determining process mastery, they pose special challenges for assessing knowledge in relationship to content standards (what students should know), which have been traditionally measured by standardized paper and pencil tests.

Use of standardized tests, as significant evidence of school quality and reform progress, and public scrutiny of their results force school personnel into defensive positions. Principals and teachers perceive threats to their livelihood, and antagonistic political pressure can "derail" reform efforts (Darling-Hammond, 1994).

Tests ought to measure what matters, and many assessment researchers are not advocates of high-stakes testing. Baker, Glaser, & Jones (1999) agree that the more we keep students, the more they achieve--the more we engage them, the more we keep them. According to these researchers, there should be measures of what matters, beginning with engagement. We have not yet adopted this insight in local, state, or national assessment approaches. We lack instrumentation, or perhaps we have not acknowledged instruments at hand for the right purposes. Standardized test misuse is a major threat to the success of systemic reform implementation (Cuban, 1991).

A number of pedagogy, policy, and science education researchers assert that meaningful and positive change will result when principals and teachers are allowed to de-emphasize testing and lead from the trenches, using "best practices" to create domino-like examples of student success. The most powerful regulator of practice is the quality of the dynamic between principals and teachers (Cuban, 1989). School system policy and practice frame the interaction, and in the current reform environment, decentralized decision-making facilitates the authority of principals and teachers to shape implementation. Beliefs guide human interactions, and unless professional development efforts are effective in shaping mind-sets for "untracking science education," traditional mind-sets about who can do science will prevail (Kyle, 1998; Wells & Oaks, 1996).

In decentralized decision-making environments, vision and influence from the top levels of the system are particularly important. The rapid turnover of superintendents in urban schools works against development of stable, appropriate,

systemic mind-sets to support reform implementation (Hess, 1998). Reform implementation appears most advantaged when goals of movement are clear in the minds of key decision-makers. Communities attempting to reform schools would do well to support superintendents who understand authentic achievement and will risk establishing system-based evaluation criteria that assists principals and teachers in organizing instruction to allow students maximum opportunities to produce knowledge, create things, and demonstrate understanding (Education and Urban Society [editorial], 1992). The highly charged political environments surrounding most superintendents, given the often adversarial relationship of school boards with their system leaders does not support appropriate goal-setting and risk-taking necessary to reorient thinking and engage in practical behaviors that engender student success (McAdams, 1997; Darling-Hammond, 1994).

Formation of Coalitions of Actors and Stakeholders

Urban stakeholders need tools that facilitate thinking together about how to improve ineffective systems that are not equipping students with literacy and thinking skills (Darling-Hammond, 1995; Fullan, 1996; Goodlad, 1998). Despite questions of whether merely setting standards and measuring achievement can improve teaching and learning, doubters and reform supporters, alike, can acknowledge the utility of standards-forced problem-solving, with a clear view of achievement levels which, if reached, improve hope and opportunity.

Standards, then, allow parents and other community constituents of school boards, to take stock and require an alignment of resources. Research suggests that success of reform implementation is related to "local context and the vision of change agents," as well as that of those who emerge as leading stakeholders, specifically in community and political roles (Zetlin & Lim, 1998, p. 516). It is important for political agents to do more than make noise that benefits broader political agendas. Effective reform advocacy for constructive change requires understandings that are shared among the professional education community, local community-based social and political institutions, as well as the larger economic and technical employment community (Tyack & Cuban, 1995; St. John & Pratt, 1997).

Some research advocates reform that creates an environment where stakeholders demand human, physical, curriculum resources, as well as system accountability for transforming urban schools into high achievement, success-focused environments, providing "high quality, rigorous mathematics and science education to all students" (Westat*McKenzie, October 1998, p. 7).

Teachers work directly with students, so discussions of capacity often focus on what teachers need to know and be able to do. Early discussions of the knowledge base for teaching addressed both propositional knowledge and procedural knowledge or skills. Consequently, discussions of staff development dealt with the content to be learned in workshops and the methods of skills and training. Theorists subdivided knowledge into areas such as knowledge of subject matter, knowledge of curriculum, knowledge about students, and knowledge about general and subject-specific pedagogy. Recognizing that teachers might know how to teach in a particular way yet still not do so, researchers have called attention to other areas of teacher capacity. In order to enact reform, for example, teachers must have the disposition to meet new standards for student learning. Studies of teachers' attempts to change their practice suggest that the capacity to teach in new ways is also connected to teachers' views of self, to their beliefs about their role in classroom activity, and to the personality they adopt in the classroom. Also critical are teachers' views of themselves as learners, including what, where, and how they will learn. Thus building teachers' capacity to enact reform means more than helping them gain additional [subject] understanding and [pedagogical] skill; it also means encouraging them to alter the goals they hold for their students and to change the way they see themselves.
(Floden, Goertz & O'Day, 1995, p. 21).

Glidden (1999) described schools in low-income communities with above national average schooling results, including test scores, attendance, grades and completion rates. He attributes differences in the success indicators of demographically similar schools to differences in school building cultures. More successful schools have more engaged school cultures and climates.

Building engaged culture is related to the complex issue of developing reform capacity. As researchers Floden, Goertz & O'Day (1995) write, even when the vision is clear, policy and goals are aligned and teachers are willing, the system lacks the critical knowledge, capacity and resources for effective reform implementation.

Teachers' perceptions are important, and a major issue in reform implementation may emerge as the disjunction between beliefs about successful urban teaching held by professional reformers (university subject area and pedagogy specialists) and experienced teachers. Ilmer, Snyder, Erbaugh, & Kurz (1997) found significant difference between the views of university teacher educators and experienced teachers about the importance of responding first to "children's needs" as a factor associated with successful teaching in urban schools. Teachers were found to view responding to children's needs as more important than university educators did. The concern for caring culture has, perhaps, been overlooked by science/math education reformers, although it is difficult to ignore the large body of literature related to urban schooling, in the context of USI implementation concerns.

Culture as a Factor in Urban School Reform

Several factors associated with culture appear relevant to discussions of reform implementation in urban schools (Hollins, 1999; Chin, 1996; Ladson-Billings, 1994; Foster, 1993; Irvine, 1990; Cochran-Smith, 1997). Salient views emerging from this literature cohere with those of the science/mathematics education reform community, along the following dimensions:

1. Teachers and their advocates do not accept low achievement or failure to produce;
2. Teachers and their advocates are highly involved in planning for students with each other and with students;
3. Teachers link students to external resources and experiences;
4. Teachers lead and drive planning;
5. Teachers control some resources;
6. Teachers and students interact in defined small groups;
7. Students care about each other and value belonging to the school group;
8. Students connect their academic work with larger purposes and with achievements that they target for themselves;
9. Students have responsibility for achievement;
10. The principal is an optimistic facilitator, working to support the achievement defined by students and their teachers.

TEACHER TRAINING AND PROFESSIONAL DEVELOPMENT

Teachers' Perceptions of Change Capacity Influence Change Potential

Teachers' perceptions of whether internal and external supports are appropriate and helpful appear related to levels of change reported in teaching/learning behavior. School-building level instructional design teams, led by former teachers who have enacted preferred instructional models are influential. There is some tension between the understood value of teachers owning, by creating, their own instructional models and the teachers' concern that they need concrete examples of models that work (Bol, Nunnery, Lowther & Dietrich, 1998). This tension is likely an artifact of the challenge for building capacity that is neutralized as teachers own membership in supportive professional community.

Teacher development in a supportive professional community appears an essential system capacity, in evidence in environments where student understanding and success define the purpose of schools (Floden, Goertz, & O'Day, 1995). Hollins (1999) describes a process for helping teachers develop habits of mind that support student achievement. According to this work, student achievement is positively influenced when teachers and administrators talk and think in positive ways about the educational needs of their students. Students learn when teachers are active problem-solvers, engaged with their students and each other in figuring-out curriculum.

Effective Professional Networking Associated with Student Achievement

In research designed to connect two significant longitudinal studies, the National Educational Longitudinal Study (NELS:88) and the 1984 High School and Beyond teacher survey, researchers relate teachers' assessments and perceptions of students' abilities to amount of collegiality and level of involvement in professional learning communities (McLaughlin and Talbert, 1993). Teachers with more collegial support have more positive views of their students' potential. Teachers who are engaged with colleagues are most able to adjust practice to facilitate student learning or success.

Research appears to support the importance of teachers working with other teachers, to solve problems related to the achievement of their students. Teachers benefit

from active relationships with other professionals in industry and higher education. Such associations form effective professional development networks. The teachers and their professional development partners are most effective when they view deficits in student performance as problems that are resolvable, given use of appropriate strategies and access to resources. Students achieve more success when teachers work as problem-solvers and supportive colleagues within the school building and within a professional development network.

It appears that a key reform implementation challenge is alignment of expectations for system accountability with long-range capacity-building behavior. Falk and Ort (1998) warn that unless teachers have opportunities to work with standards in ways that allow them to balance their individual views (or perhaps in the case of experienced urban teachers a collective view of what constitutes best strategies for working with their students), standards-based reform is "toothless." Of equal concern are state and local school district approaches that penalize teachers by holding constant expectations, using standards rhetoric, without learning about students and their work. Reform implementation conducted in this spirit undermines essential teacher decision-making and professional insight. Research suggests that teachers interacting with other teachers, students, students' families and communities about authentic student work is critical engagement for supporting desired change (Falk & Ort, 1998). Taken together, engaging, networking, reculturing and restructuring appear to provide critical underpinning for long-term positive school change (Fullan, 1996).

Attracting, Employing and Retaining Effective Mathematics and Science Teachers: Supporting High Achievement through Course-Taking Behavior

The content backgrounds of teachers influence school capacity to offer courses in the schooling sequence associated with competitive student performance. When the mathematics achievement scores of 13 year old American and Japanese students were compared in 1992, the aggregate score of American students was 6.4 points lower than the aggregate score of the Japanese students. When disaggregated by type of mathematics course taken, the score of 13 year old Americans who had taken algebra was 10.6 points higher than the aggregate score of 13 year old Japanese (U. S. Department of Education (1993). To provide access to courses associated with higher achievement, school districts must have teachers who are qualified to teach those courses. Goldhaber & Brewer (1998) found evidence that subject specific training for math and science teachers has a statistically significant positive impact on student achievement, when achievement is measured by standardized tests.

The predicted magnitude of the effect of teacher training on student achievement is relatively small. In science, the mean 10th grade test score was about 22 with a

standard deviation of 7.5. Having a science teacher with a bachelor's degree in his or her subject is predicted to add about .7 points to the average science student's score relative to what the student would have received had the teacher not had a bachelor's degree in science. Thus a science-specific bachelor's degree is worth about one-tenth of a standard deviation improvement on the 10th grade science test. [In mathematics]...again, the improvement is relatively small. The difference in predicted scores for a student whose teacher has a bachelor's degree (not in math) and one whose teacher has a bachelor's degree and a master's degree in math is about 1.4 points. This is only one-tenth of a standard deviation on the 10th grade mathematics test (Goldhaber & Brewer, 1998, p.134).

In the same study, these researchers confirmed previous findings that 75% of achievement, when measured by tests, is explained by individual and family backgrounds, such as level of parents' education. They conclude that to the extent school districts are interested in improving student performance on standardized measures, those districts will pursue employment of appropriate reward mechanisms to keep math and science teachers with degrees in those disciplines. This research, and other work, found primarily in work relating economics and education, find little relationship between schooling inputs, such as class size and teacher pay, on student achievement (Card & Krueger, 1996; Ehrenberg, 1994; Ehrenberg & Brewer, 1995). The challenge, it might appear, is to attract and retain professionals with mathematics and science degrees for teaching positions in high poverty schools.

If, however, 75% of achievement can be explained by socio-economic and personal variables, what is the systemic change power of the reportedly "small" positive differences attributed to the teachers subject matter preparation or, for that matter, any of the other reform driver variables? This research forces an unresolved quandary for those seeking predictive, mathematics-based models for explaining student achievement in urban communities, which are characterized by concentrations of poverty, particularly if standardized achievement measures are the predominant regulators of system practices.

Additionally, findings of researchers on the impact of the Chapter 1 (a federal compensatory program, a.k.a. Title I) are germane to questions of predictive and correlative variables associated with academic achievement in high poverty schools. Using standardized test measures, this research also indicates that students in high poverty schools are far less likely to master basic reading and mathematics skills than are their counterparts in lower poverty schools, with a more pronounced performance gap in higher order thinking tasks (Puma, Karweit, Price, Ricciuti, Thompson & Vanden-Kiernan, 1997, in McClure, 1997). Further, these researchers found that students receiving specialized, "pull-out" services scored lowest when they received more intensive services, and that over time, the services did not "close the performance gap between economically disadvantaged students and their more advantaged peers" (McClure, 1997, p. 342).

The research also found that authentic classroom work samples which rated top grades in high poverty schools were rated average and below in low poverty schools. Additionally, access to a large national, longitudinal database allowed the research to view a range of factors and their influence on standardized test measures. A review of the findings yields the following observations:

One of the more interesting findings of this research relates indirectly, but perhaps significantly, to the work of Goldhaber & Brewer (1998). Puma et al. (1997; in McClure, 1997) found that in the highest poverty, lowest achievement schools services were provided by the least well credentialed (paraprofessionals or aides) personnel. Although Goldhaber & Brewer (1998) argue that certification and degrees in other than math/science content have insignificant impact on test-score-measured student achievement, their work taken with the McClure (1997) report of Puma et al. (1997) findings, appears to strengthen the case for professional development, as a key factor in efforts to improve school outcomes.

> *... based on a longitudinal sample...some factors...had strong, positive, and consistent relationships to improved student outcomes for disadvantaged learners. Among student and family characteristics, ... parents' expectations for better than average grades and future college attendance were positively and significantly related to scores on standardized achievement tests and teacher ratings. School factors were also associated with better student outcomes; those with lower concentrations of poverty (independent of the economic status of an individual) produced higher standardized achievement test scores. Other school characteristics positively related to student achievement were: avoiding grade retention (retained students had lower test scores than their classmates), an instructional emphasis on comprehension and the development of and appreciation for the ability to write, lower levels of student disciplinary actions, and household stability in the early grades. (McClure, 1997, p.342).*

Additional research reported by McClure (1997) indicates that when researchers performed a disaggregated analysis of Chapter 1 data, they found more positive results with the more economically disadvantaged students and greater reduction in the performance gap between more and less impoverished students associated with active collaboration and coordination of curriculum materials between Chapter 1 and regular classroom teachers (D'Agostino, Wong, and Hedges {in press}, as reported by McClure, 1997). Research findings, again, implicate the centrality of effective teacher behavior in changing student outcomes, with urban, poor students. Given that we are "stuck" with standardized measures until we evolve effective formative and summative authentic approaches, schools, then, are challenged to attract well prepared teachers and provide environments that foster their effectiveness.

The literature suggests that effective teachers work in environments where the ethos and culture of the teaching community support problem-solving discussion and

behavior among colleagues, supported by a professional development community of other experts (Hollins, 1999; Glidden, 1999; Swanson, 1995; Gold & Roth, 1993; Goodlad, 1993; Weisbender, Champaign, & Maddahian, 1989; Veenman, 1984). When these conditions exist, change or measurement by external standards is more easily accommodated, and experts believe that use of new standards and high stakes testing are less intimidating.

Instead of adhering unquestioningly to artificial external pressure and failing many students, or resorting to practicing for the test, effective schools encourage hands-on, minds-on problem solving (Kyle, 1997 ; Bradley, 1991). In these environments, teachers assume empowerment to nurture understanding, insight, and excitement. The school community--all stakeholders--celebrates authentic demonstrations of student achievement (Darling-Hammond, 1995; Siddle-Walker, 1999).

CONCLUSION

Summary of Theoretical Chain of Influence Leading from Policy to Classroom Practice to Student Performance

Policy alignment under girds the notion of systemic change. When the six NSF driver variables are analyzed with guidance provided by the framework offered by Knapp's (1997) "avenues," critical relationships emerge between policy and systemic behavior. The review of research studies reveals little or no researcher agreement regarding variables to be used as criteria in model building.

There is general agreement that teacher variables and thus professional development are key to student success; however, there is little agreement about what constitutes appropriate professional development. In some instances it is viewed as improved teacher content knowledge, elsewhere it is improved pedagogical approaches for presenting content, while other researchers view professional development activities as improved cultural immersion on the part of teachers. Regardless of how it is defined, professional development is a significant variable in research investigating systemic change.

Additionally, researchers rather universally agree that curriculum is a central issue in improving student performance. During the last decade this seems to have evolved under the term "standards-based curriculum." Teaching and learning capacity in standards-informed environments is a reflection of the quality of leadership provided for and problem solving directed towards teacher training and development. Thus professional dynamics that influence curriculum should be a central issue in any model building.

Finally, student performance variables, while pivotal to model building suffer from the vague agreement about what performance measures constitute appropriate indices. Certainly, student knowledge utilizing some standardized measure should be one component of any model. This could vary from state-mandated tests to standardized measures such as the CAT, ITBS, CTBS-4, etc. Measures of qualitative indicators such as student and teacher engagement are important to equity concerns.

There is little guidance in the research literature to inform construction of a causal model beyond the global areas enumerated above. The complexity of the reform endeavor derives from the highly interactive nature of the drivers. The current research distills the relationships to interactions in three key strands--policy, professional dynamism, and assessment.

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APPENDIX A:

USI EVALUATIVE STUDY ABSTRACT

The purpose of the study is to determine the impact of the National Science Foundation's Urban Systemic Initiative (USI) program on student achievement and the learning infrastructure in urban school districts, and to develop an inferential causal model that relates the SI drivers and other key elements to the outcomes observed. Our study team will analyze the effectiveness of the USI program from five different perspectives: across all 21 USI sites; by USI cohort; longitudinally within sites; by comparison with 7 non-USI cities; and within a national context that includes other major reform efforts.

The study team will develop a Key Indicator Data System (KIDS) to collect/compile annual core data from the baseline year using both quantitative (K-1) and qualitative templates (K-2). Our study team will conduct an annual KIDS workshop designed for USI core data managers and evaluators to enhance data integrity and share expertise. Based on collaborative research agreements, we will receive SAT-I, AP, and ACT test results (as part of K-1 data) directly from the Educational Testing Service, the College Board, and ACT, Inc., respectively, for the next three years.

Each year, the team will conduct four site visits including interviews with USI leaders, focus groups, and school visits, to further explore detailed implementation issues. In addition, a modified version of the Council of Chief State School Officers' Survey of the Enacted Curriculum will be administered to 80 selected math and science teachers within these four sites. Finally, we will gather and review information from national databases such as the Third International Mathematics and Science Survey (TIMSS), National Assessment of Educational Progress (NAEP), Goals 2000, Equity 2000, as well as the USI sites' annual reports and relevant documents.

The team has identified key research questions in eight areas mapped to the NSF drivers: (1) student outcomes, (2) curriculum and instruction, (3) assessment instruments, (4) professional development, (5) policy, (6) leadership, governance, and management, (7) convergence of resources, and (8) broad-based support for reform. We will use a variety of statistical analysis methods to validate the hypothesis that a well-implemented USI program has a positive impact on student outcomes. Further systemic analysis will explore the determinants of successful implementation of urban reform in mathematics, science, and technology education.

During the three-year study period of October 1998 to September 2001, we will produce a USI Annual Fact Book and USI Evaluative Study Report, both in print and in CD-ROM format, and a master data base to be available on the world-wide web. Beginning in Year 2 we will publish a series of newsletters and monographs detailing our research findings.

Our research team has expertise in systemic education reform, assessment, evaluation, academic research, and core data collection and analysis. A research team of three co-Principal Investigators, all of whom have been involved in the NSF systemic reform effort, will be led by Dr. Jason Kim (PI) of Systemic Research, Inc. An advisory committee with representation from other major national reform initiatives will provide further review and consultation in order to situate the proposed study in the national context.

Evaluative Study Team	Advisory Panel Member
• Dr. Jason J. Kim (PI) /Systemic Research, Inc. • Dr. Rolf Blank (Co-PI) /Council of Chief State School Officers • Dr. Pendred Noyce (Co-PI)/Noyce Foundation • Dr. Lloyd Richardson (Co-PI) / University of Missouri- St. Louis • Dr. Melva Ware /University of Missouri- St. Louis • Dr. Hunhee Ken Lee /Systemic Research, Inc. • Ms. Jennifer Manise /Council of Chief State School Officers • Mrs. Linda Crasco /Systemic Research, Inc. • Mr. Don Lee /Systemic Research, Inc.	• Dr. Lloyd Cooke /LMC Association • Dr. David Grissmer / RAND Corp. • Ms. Sharon Lewis /Council of Great City Schools • Dr. William Schmidt /Michigan State University • Ms. Clara Tolbert /Philadelphia USI • Dr. Yuwadee Wongbundhit /Miami-Dade USI **NSF Program Directors:** • Dr. Bernice Anderson /Division of Research, Evaluation and Communication, Directorate for Education and Human Resources • Ms. Celestine Pea /Division of Educational System Reform, Directorate for Education and Human Resources

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